

# **Chinese Saving Dynamics: The Impact of GDP Growth and the Dependent Share**

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## **Abstract**

China's national saving rate rose rapidly in the 2000s after declining through the late 1990s. These dynamics are not explained by precautionary motives, the institutional distribution of income, or reform related processes in general. Rather, we find a compelling explanation lies with GDP growth fluctuations and movement in the dependent share in population. We estimate a vector autoregressive model for the period 1978-2008, then generate in-sample simulations that successfully replicate the 2000s run-up in the saving rate. Our out of sample forecasts show the saving rate dropping in the 2010s as the dependency share falls and GDP growth moderates.

(JEL C32, E21, O11, O53)

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# **Chinese Saving Dynamics:**

## **The Impact of GDP Growth and the Dependent Share**

Many explanations for China's high rate of national saving have been proffered, and any or all of them may hold some measure of truth. But the phenomenon of Chinese saving, as it has attracted attention in relation to global imbalances, is about more than just a high rate of saving. Only with a very rapid increase in China's saving rate in the 2000s did saving diverge from domestic investment to yield a ballooning trade surplus and a massive accumulation of foreign reserves. Prior to this, through the late 1990s, China's saving rate was actually declining. To explain the imbalances that erupted in the mid-2000s then, a theory of Chinese saving behavior must account for a sudden, sharp rise in the saving rate.

In section 1, we assess alternative theories of Chinese saving behavior. We argue that the the dependent share in the population and the growth rate of GDP offer the best prospects for explaining observed movements in the saving rate. In section 2, we compile data series for these variables for the period 1978-2008. Section 3 presents results from estimation of a vector autoregressive (VARX) model that treats the saving rate and GDP growth as endogenous variables and the dependent share as exogenous. The model is shown to perform well in explaining the 2000s increase in the saving rate. Section 4 applies the model to simulate paths for the saving rate under alternative assumptions regarding growth and demography. Section 5 concludes by noting that the momentum is shifting toward a decline in the saving rate in years to

come as the dependent share turns upward and GDP growth moderates. This bodes well for a rebalancing of the economy.

### ***1. Theories of Chinese Saving Behavior***

Explanations for China's high and rising saving rate have generally revolved around three main themes. The first holds that economic reform has pushed the household saving calculus toward a more precautionary stance (Chamon and Prasad 2010; Lardy 2006; Blanchard and Giavazzi 2006). The second maintains that distributional forces have shifted income from consumption-oriented households to saving-entrenched enterprises (Kuijs 2006; Aziz and Cui 2007; Pettis 2009). The third draws on Modigliani's (1970) life cycle model to emphasize faster growth in income and a falling dependent share in population (Modigliani and Cao 2004; Horioka and Wan 2007; Kraay 2000).

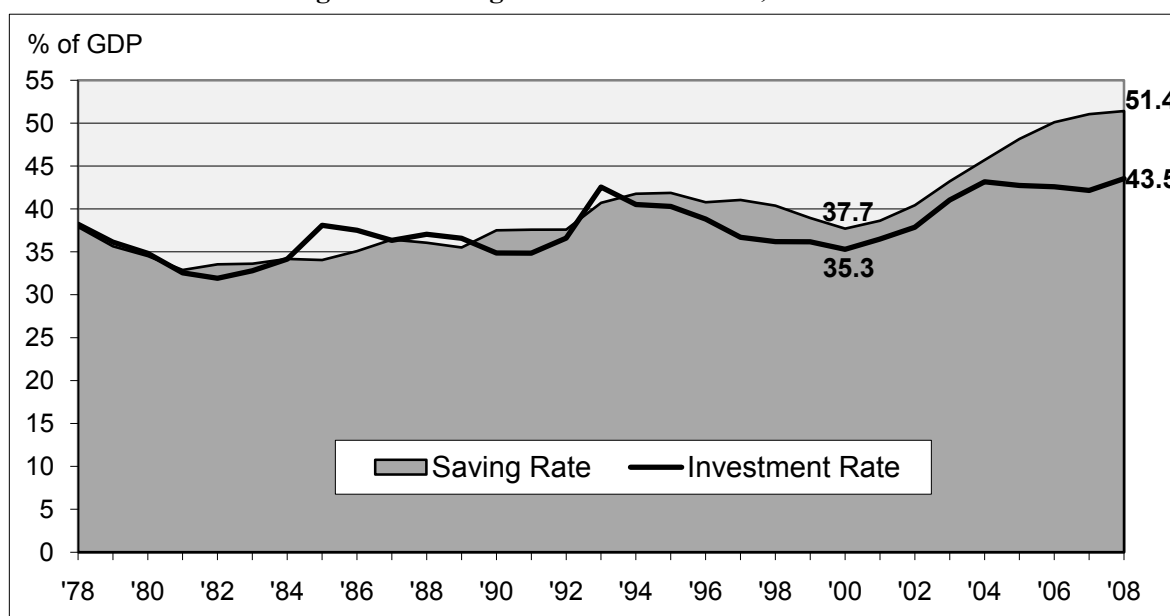
Neither the first nor the second explanation can account for movements in China's aggregate saving rate in the 1990s and 2000s.<sup>1</sup> As shown in Figure 1, saving as a share of GDP reached a historic peak in 1995 of 41.9 percent having trended generally upward since the early 1980s. It then turned down through the late 1990s, bottoming at 37.7 percent in 2000. From there it surged, gaining 13.3 percentage points in just seven years between 2000 and 2007. Although the run-up in the saving rate began in 2000, imbalances did not erupt until after 2004. Until that point, the investment rate tracked the saving rate closely leaving only a modest saving-investment gap of 2.0-2.5 percent of GDP. From 2005 on, though, the investment rate was held

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<sup>1</sup> Other factors that have been cited for China's high saving rate suffer from the same failure to account for a saving rate decline in the late 1990s followed by a rapid rise in the 2000s. These include the low share of employment in the service sector, the low level of financial development, and an undervalued real exchange rate (Guo and N'Diaye 2010), as well as saving competition for brides (Wei and Zhang 2009).

in check through policy measures while the saving rate maintained its upward momentum.<sup>2</sup> In 2007, the saving/investment gap – and its reflection in the trade surplus – reached 8.9 percent of GDP, falling to 7.9 percent in 2008.

**Figure 1: Saving & Investment Rates, 1978-2008**



Data source: China National Bureau of Statistics

An explanation for high saving that rests on the precautionary motive and insecurities related to economic reform does not jibe with a decline in the national saving rate in the late 1990s followed by a steep rise in the 2000s. The late 1990s marked a high tide for reform of the urban economy. The state sector was down-sized radically, the line ministries and with them the state planning apparatus were abolished, workers were laid off in droves, and housing was privatized – all largely by 1998 (Liu 2010). Yet as life was becoming palpably more insecure, the saving rate fell. Conversely, it resumed its upward climb just as China joined the World Trade Organization and an economic boom got underway in earnest. Through the 2000s, gradual progress was made in building a social welfare system and increasing public support for health

<sup>2</sup> See Woo (2006) for an explanation of how policy restraints on investment have driven imbalances.

and education. Under the banner of “building a harmonious society”, the rural minimum living allowance was established in 2005, the new rural cooperative medical scheme began to take shape in the same year, and free compulsory education through ninth grade was decreed in 2006 (Wong 2010). The urban pension system established in 1998 was reparameterized in 2005 to provide more generous benefits (Organization for Economic Cooperation and Development 2010, 196). Survey research by Whyte (unpublished, results subject to revision) shows health insurance coverage expanding from 29 percent of the population in 2004 to 82 percent by 2009. By all appearances then, the precautionary motive for saving should have been receding by the mid-2000s, yet the saving rate continued to climb.

Despite the logic of a diminishing need for precautionary saving as the 2000s unfolded, empirical work by Chamon and Prasad (2010) led them to conclude that “precautionary motives and the rising private burden of social expenditures has driven the increase in household savings rates.” (p. 96) Their study draws upon urban household survey data for the period 1990-2005. For this sample, the saving rate trends generally upward throughout the period. As the authors show in an appendix table, however, the upward trend exhibited by their household data does not track with the aggregate household saving rate from the national accounts. The national accounts show a consistently higher household saving rate than the household survey data with a pattern that follows the national saving rate in declining through the late 1990s, then rising rapidly in the 2000s. China’s National Bureau of Statistics, in arriving at the household saving rate reported in the national accounts, uses the household survey data as one point of information among many to produce a composite picture. Any statistical inferences drawn from the urban household survey data are thus of limited relevance for understanding movements in the aggregate household saving rate. To conclude, as Chamon and Prasad do, that “our preferred

explanations for the high and rising savings rates are related to China's transition to a market economy" belies the observation that life was becoming less secure as the national saving rate fell and more secure as it later went back up.

Another theme in explanations of Chinese saving behavior involves the distribution of income by institutional type. The argument is that market distortions have redistributed income from households, who would consume the bulk of their receipts, to enterprises, whose retained earnings are by their nature saved in full. As Pettis (2009) puts it, "By transferring wealth from households to boost the profitability of producers, China severely hampered its ability to grow consumption in line with growth in the nation's GDP." Among policies that "systematically forced households implicitly and explicitly to subsidize otherwise unprofitable investment in infrastructure and manufacturing", Pettis lists: an undervalued currency; excessively low interest rates; a large spread between deposit and lending rates; sluggish wage growth due in part to restrictions on labor organizing; the unraveling social safety nets; and manufacturing subsidies including controlled land and energy prices. Also adopting this line of argument, Aziz and Cui (2007) cite the decline in the household income share in GNP rather than the rise in the household saving rate as "the elephant in the room"(p. 3) in explaining national saving and consumption patterns. Like Pettis, they see distortions in the financial sector as a powerful redistributive force, particularly as these distortions deprive small firms of working capital and thereby inhibit wage and employment growth.

The problem, again, is that this line of argument does not explain the observed decline in the national saving rate in the late 1990s and its rise in the 2000s. Based on flow of funds data revised retrospectively in 2009 by China's National Bureau of Statistics (accessed through

CEIC), the share of household income in national disposable income (NDI)<sup>3</sup> began a long decline from a peak of 68.6 percent in 1997 to 57.5 percent in 2007.<sup>4</sup> Until 2004,<sup>5</sup> most of the complementary gain in income share went to enterprises. Then, from 2004 to 2007, the enterprise share in NDI contracted while the government share expanded substantially from 18.9 percent to 24.1 percent. While in principle the rising government share in income could have been allocated to public consumption, in fact the government consumption share in NDI continued on a declining path even as the government income share rose. Government was thus a substantial contributor to the rising national saving rate in the mid-2000s. In any case, the bottom line is that income shifts from households to enterprises have not tracked the movement of the national saving rate.

By contrast, the household saving rate did move in sync with the national saving rate, declining in the late 1990s, then rising sharply in the 2000s as shown in Figure 2. This pattern came through, too, in household saving as a share in NDI which fell from 21.6 percent in 1997 to 16.6 percent in 2000, then rebounded to 21.8 percent in 2007. Thus despite the protracted decline in the share of household income in NDI through the 1997-2007 period, the pace was not sufficient in the 2000s to overcome the impact on national saving of a strongly rising household saving rate. The pattern in household saving thus fed through to the national aggregate.

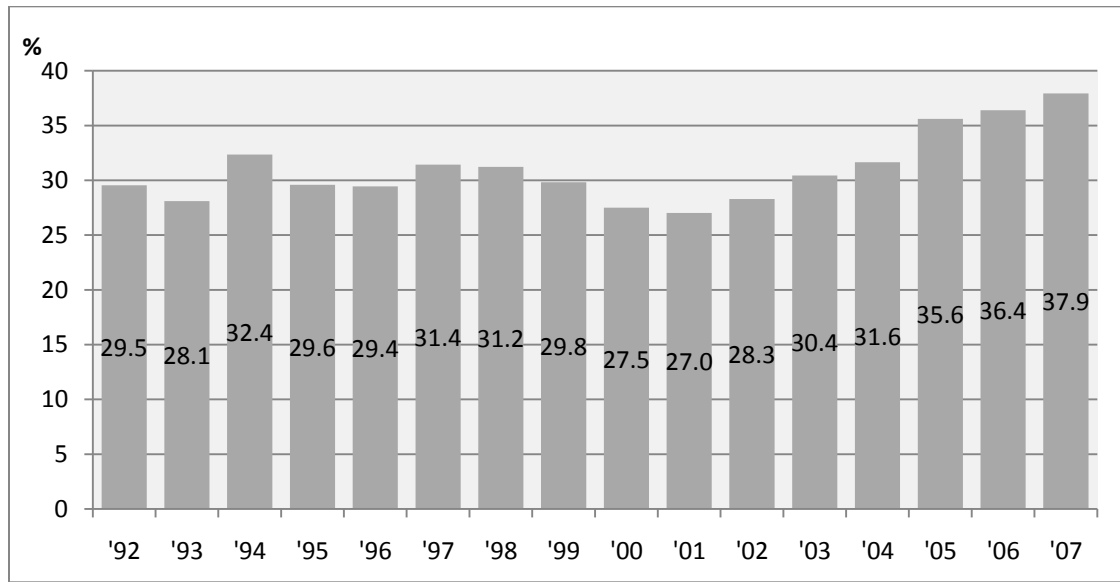
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<sup>3</sup> National disposable income is the appropriate denominator against which to measure income shares because it comprehensively reflects all sources of income including net foreign-sourced factor income and transfers.

<sup>4</sup> Wiemer (2009) provides a detailed accounting of shares in income and saving by institutional type to substantiate the role of households and government in driving the increase in the national saving rate during the 2000s.

<sup>5</sup> The year 2004 shows erratic movement in income shares. Bai and Qian (2009) note that the economic census taken in that year provided the basis for a different methodology to be applied in compiling national statistics. They provide the service of cross-checking the flow of funds with other national accounts data, but use an earlier version of the flow of funds series that was overridden by the 2009 release. The revised series still appears to exhibit a discontinuity in 2004. For purposes of our analysis, we abstract from this discontinuity in examining longer-term trends.

**Figure 2: Household Saving Rate in Disposable Income, 1992-2007**



Data source: CEIC from flow of funds.

A story of China's national saving rate rising due to market distortions causing income redistribution from households to enterprises is not supported by the data. Moreover, this story usually takes such distortions as key to the Chinese growth model for their role in channeling resources to the state. It is a story of saving being forced upon the populace in order to achieve growth. But such causality running from saving to growth is, as a rule, also not supported by the data. Rather, cross-country studies have widely affirmed that causality runs in the opposite direction from growth to saving. For example, an application of panel techniques to a sample of 98 countries by Loayza, Schmidt-Hebbel, and Serven (2000) found that an increase in the real growth rate of NDI of one percentage point raised the national saving rate by 0.45 percentage points one year later. The ultimate effect was more than double that due to the tendency for saving increases to persist and to feedback on growth. This result was essentially unaltered when the model was applied more narrowly to private saving, and the authors found generally "that the public saving rate is driven by the same determinants as the private saving rate." Vivid evidence



that a rise in saving has indeed followed, not preceded, faster growth is to be found among the successful developers of East Asia. Graphical analysis for South Korea, Singapore, and Vietnam presented in Wiemer (2008) shows that in all three cases, the saving rate climbed persistently long after the country entered an era of high growth.

This finding points to the third theme among explanations for China's rising saving rate which recognizes income growth and demographics following Modigliani. The foundation of the argument is that saving varies over the course of the life cycle. Because young and old age dependents consume while generating little or no income, populations with high proportions of youth and elderly tend to exhibit relatively low saving rates. The converse applies in the Chinese case where, due to the fall-off in the birth rate beginning in the 1970s, small youth cohorts and an expanding demographic concentration in the working ages have stoked a rising saving rate. The income growth rate comes into play in the Modigliani model because working age cohorts who benefit from the impact of higher growth on income save more relative to the dissaving of retirees who built their nest eggs in a lower-earning era. A counter-argument to this, however, is that when higher growth is anticipated, young earners would be expected to borrow against future wealth (or in the absence of well-functioning capital markets at least not save as much) in order to spread consumption more evenly over their lifetimes. Carroll, Overland, and Weil (2000) argue that for reasonable parameter values of the utility function this "human wealth effect" dominates Modigliani's "aggregation effect". The result is that higher growth does not lead to a higher saving rate and on the contrary may lead to a lower saving rate. This reasoning prevails, however, only if the higher growth is anticipated. If it is unanticipated, Friedman's (1957) permanent income hypothesis comes into play with higher growth leading unambiguously to higher saving.

Carroll et al., propose an alternative basis for growth to cause saving even when the growth is sustained and anticipated. Theirs is a model of habit formation wherein utility is a function not just of current consumption but of a habit stock of consumption derived from a weighted average of past consumption values. Households choose a current consumption level with an eye to its impact on the habit stock and hence on utility projected into the future. A given level of income is more rewarding if it has been arrived at through faster growth than through slower growth. Saving responds more positively to growth in a model with habit formation because households take advantage of an increase in income to save more and thus sustain a higher rate of income growth in future years. Fitted with reasonable parameter values, such a model of utility is shown by Carroll et al. to “generate growth-to-saving causality that is qualitatively similar to that observed in the data.” (p. 1)

Modigliani himself, with co-author Cao (2004), tested the life-cycle hypothesis for China in what he called “a fitting conclusion to my life’s work.” (p. 145) Using aggregate time series data for the period 1953 to 2000, the authors obtained results indicating strong confirmation of a role for both the dependency ratio and the rate of income growth in influencing saving. Such a finding in this context is not surprising. China’s household saving rate was below ten percent and trendless during the command economy era. It surged from 1978 onward to reach more than 30 percent by the mid-1990s coinciding with both the decline in the dependency ratio that followed from a drop in the birth rate and the rapid increase in income growth that accompanied reform and opening.

The Modigliani and Cao results are in part challenged by Horioka and Wan (2007) who make use of provincial level data for the period 1949 to 2004. The cross-sectional variation captured by the provincial data cast doubt on the claim that the dependency ratio has a bearing

on saving. Confirmed though is the relationship between saving and growth with results similar in magnitude to those of Loayza et al. from their cross-country panel estimation. That is, the initial effect of a one percentage point increase in the growth rate is a rise of about half a percentage point in the saving rate with a long run effect double or more that. Horioka and Wan's results are also at odds with those of Kraay (2000). Though Kraay too uses provincial panel data, he finds saving not affected by income growth while nevertheless affected as predicted by the dependency ratio. Horioka and Wan conclude that their dynamic panel techniques are superior to the two-stage least squares method of Kraay for discerning the true nature of the relationship.

Gauging the role of growth and demographics in the saving rate increase of the 2000s is important for predicting future tendencies in the saving rate and hence for assessing the need for interventionist policies to restore domestic and external balance. Our revisions to the GDP growth series (laid out in the next section) show the 2000s to have been a period of exceptionally strong economic performance, to a greater degree even than is indicated by the official figures. At the same time, the share of young age dependents in the population took a marked drop. To the extent that these forces drove the rise in the saving rate, a reversal in their direction could well have a moderating effect on saving in years to come. This would make the rebalancing of the Chinese economy easier than is generally imagined and would undercut hardline views on the imperative of currency appreciation.

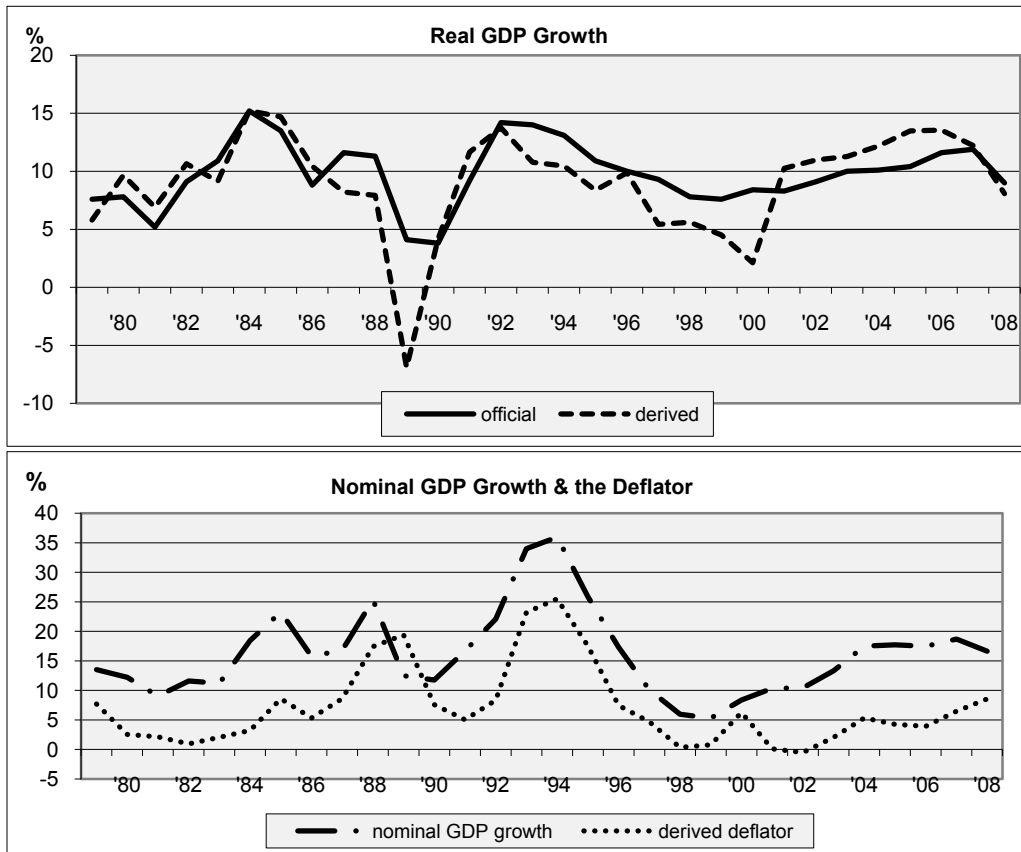
## ***2. Compilation of Data Series***

Data series for the national saving rate and the dependent share in population are suitable for use directly from official sources. To obtain an appropriate series for real GDP, we deflate nominal GDP following Young (2003). Deriving real GDP by deflating nominal GDP is

standard practice in most countries, but not so in China. China's statistical authority uses an approach to measuring real GDP that is a throwback to the planned economy. Businesses are required to report output value for the current year expressed in both current year prices and the prices of a prescribed base year. Since in today's market economy businesses do not otherwise have reason to keep track of current year output measured in base year prices the numbers supplied are likely to be off-the-cuff. Young's methodology involves constructing a GDP deflator as a weighted average of official price indexes for the three major sectors of the economy – agriculture, industry, and services.

As shown in Figure 3, the derived real GDP growth series (upper panel dashed line) follows a more erratic pattern than the official series (upper panel solid line). Arguably, the derived result accords better with experience as perceived on the ground. In particular, a recession in 1989 is shown to have been extremely deep with the real rate of growth plummeting to -6.9 percent. Nominal growth dropped to 12.5 percent in that year from 25.3 percent in the preceding year (lower panel punctuated line) even as inflation carried on its momentum pushing up to 19.4 percent (lower panel dotted line). Inflationary pressures remained strong despite the weakening economy because the dual-track system of pricing which allowed free markets to operate in parallel with the state plan was giving way under the force of plan/market arbitrage. Street demonstrations, in part a reaction to corrupt officials exploiting the arbitrage opportunities of the transitional price system, pre-empted normal economic life for two months in cities all over the country. The eventual crackdown by the government brought a retrenchment in foreign engagement with China that choked off foreign direct investment and set back development of the domestic private sector. That a deep recession transpired is consistent with these observed realities.

**Figure 3: Official & Derived GDP Growth Rates, 1979-2008**



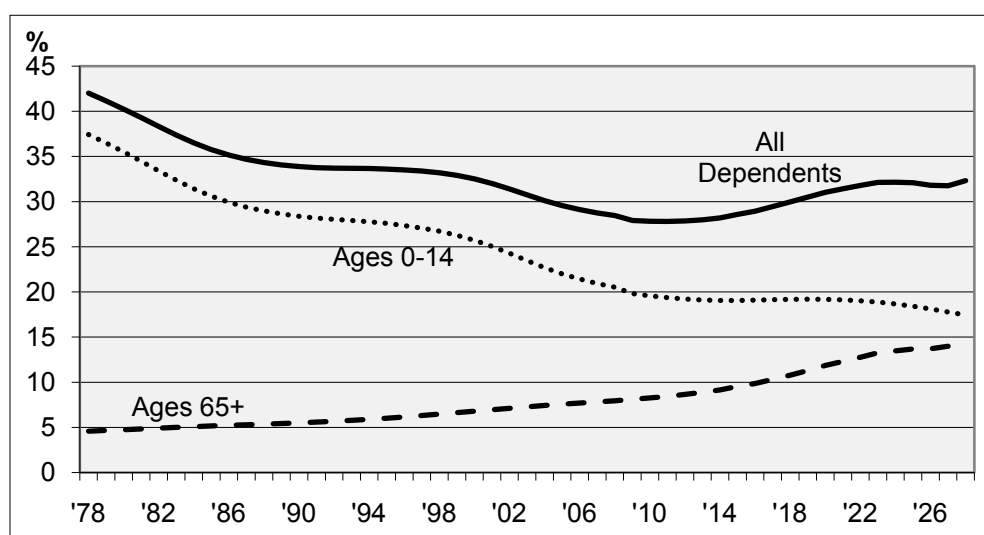
Data source: China National Bureau of Statistics

The slowdown in growth of the late 1990s is also revealed by Figure 3 to have been more severe than official statistics suggest. Domestically, the economy was beset with massive layoffs by state-owned enterprises and downsizing in government employment, while internationally, the Asian financial crisis took a toll. Modest nominal growth was undermined by inflation that rose to 6.3 percent in 2000 to leave real growth at a meager 2.3 percent. Against this deterioration in growth, the rebound that accompanied China's entry into the World Trade Organization appears far more pronounced than the official figures let on. The deflated nominal

figures show growth reaching as high as 14.2 percent in 2006. This surge in growth following a deep trough coincides with the change in direction of the saving rate.

The dependent share in the population is calculated by combining those under 15 with those 65 and older. As shown in Figure 4, after declining throughout the reform era, the dependent share is bottoming out as of 2010, poised to turn back up (US Census Bureau, 2009). Total fertility came down sharply beginning in the late 1970s inducing a long slide in the youth dependent share. Generational plateaus show up beginning in the late 1980s and again about 20 years later as larger adult cohorts give birth to larger cohorts of offspring. Longer life spans have steadily raised the share of the population age 65 and older but along a much more gradual course. From the mid-2010s, the rise in the elderly share is expected to steepen as the baby boom of the 1950s hits its senior years. A trough at the mid-2020s reflects the impact of the famine of the early 1960s on births and infancy survival.

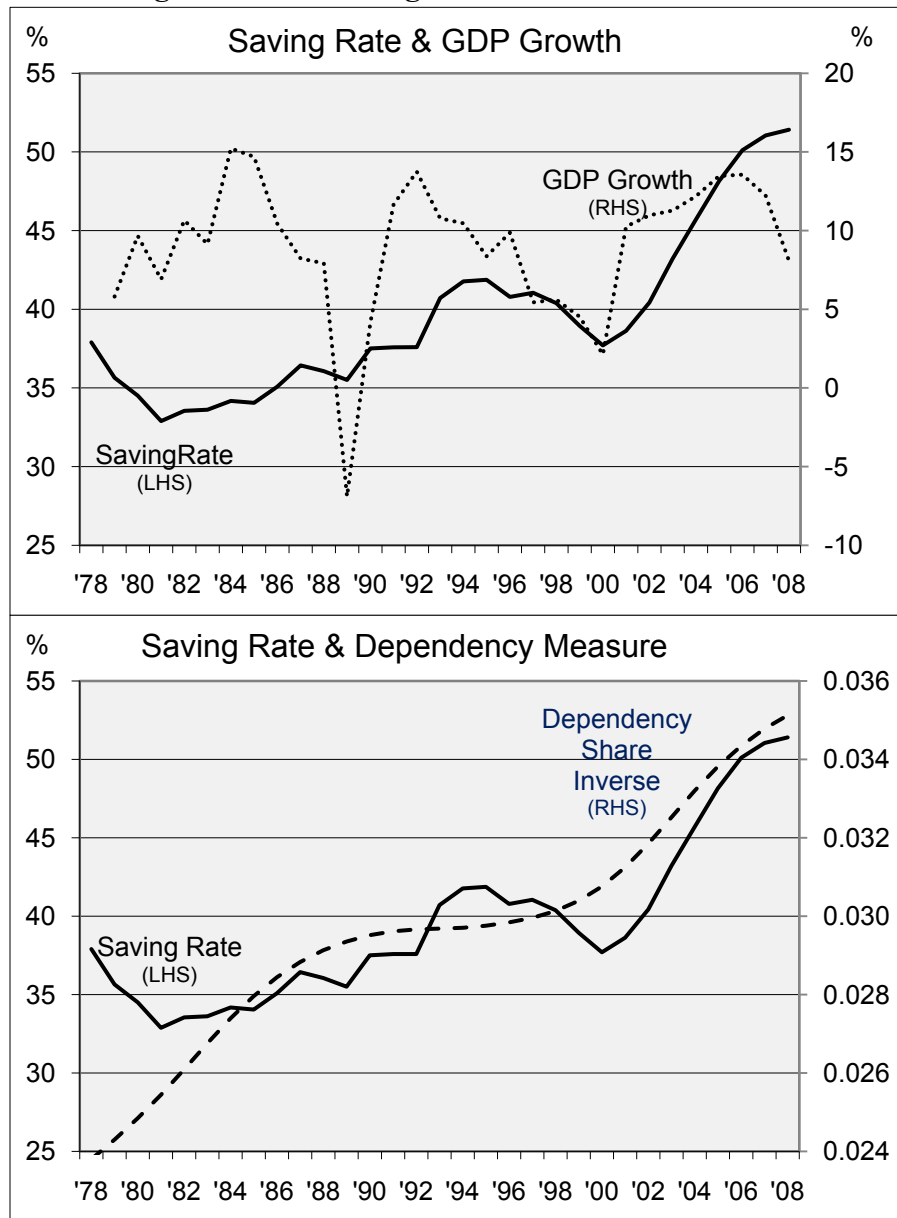
**Figure 4: Shares of Young and Old in Population, 1978-2028**



Data sources: World Bank & US Census Bureau

Juxtaposing the derived real GDP growth series against the domestic saving rate in Figure 5 brings out the association between the two. Periods of high growth correspond to periods of rising saving rates. Growth reached a level of 15 percent in the mid-1980s and the saving rate moved upward. Again in the early 1990s growth shot up to double-digit levels and the saving rate rose. The growth recession in the late 1990s then pulled the saving rate back down. Finally, the recent protracted period of extraordinary growth has seen the saving rate ascend to an unprecedented 50 percent plus. The inverse of the dependency share, in Figure 5, also shows visible co-movement with the saving rate. Most notably, both variables exhibit a steep rise in the 2000s. The rise in the dependency measure of a generation earlier does not move in such close sync with the saving rate. On the contrary, the initial break from the planned economy brought a sharp fall in the national saving rate as income shifted from a saving-oriented state to households just pulling away from the margin of subsistence. This would presumably have overridden the influence of demographic factors.

**Figure 5: The Saving Rate and Its Determinants**



### 3. Estimation of a Structural VAR

To study the dynamic relationship between China's saving rate, real income growth, and demographic change, we estimate a vector autoregressive model. The model allows, in principle, for causality to run from saving to growth as well as from growth to saving. A high level of saving facilitates a high level of investment, which in a Rebelo-type endogenous growth model



(1991) contributes to sustained high growth in output. Alternatively, in the neoclassical growth model an increase in saving only temporarily increases growth. Growth in the steady state depends strictly on the rate of technological change. With the introduction of habit formation a la Carroll et al., shocks to growth result in a transition path in which the saving rate rises over a horizon that is longer the greater the strength of habit formation. In any model though, to the extent that increases in saving are channeled abroad, as they were in China post-2004, the feedback link to output growth is undercut. Given the ambiguities, we specify a model such that the impact of changes in saving on growth may be estimated empirically, and vice versa.

Consider the simple one lag structural VAR with exogenous variables (SVARX),

$$s_t = b_{10} - b_{12}g_t + \gamma_{11}s_{t-1} + \gamma_{12}g_{t-1} + \omega_{10}d_t + \omega_{11}d_{t-1} + \varepsilon_{st} \quad (1)$$

$$g_t = b_{20} - b_{21}s_t + \gamma_{21}g_{t-1} + \gamma_{22}s_{t-1} + \omega_{20}d_t + \omega_{21}d_{t-1} + \varepsilon_{gt}, \quad (2)$$

where  $s_t$  is the national saving rate,  $g_t$  is the growth rate of real GDP, and  $d_t$  is the exogenous dependency ratio.<sup>6</sup> The shocks to the structural equations,  $\varepsilon_{st}$  and  $\varepsilon_{gt}$  are assumed to be uncorrelated white-noise disturbances. Because both equations in the SVARX allow for contemporaneous feedback, the shocks are correlated with the contemporaneous variables in each equation, and estimation by Ordinary Least Squares (OLS) is not possible. Typically the SVARX is transformed into its reduced form representation,

$$s_t = a_{10} + a_{11}s_{t-1} + a_{12}g_{t-1} + w_{10}d_t + w_{11}d_{t-1} + e_{st} \quad (3)$$

$$g_t = a_{20} + a_{21}g_{t-1} + a_{22}s_{t-1} + w_{20}d_t + w_{21}d_{t-1} + e_{gt}. \quad (4)$$

Assuming the lag length is adequate, the errors  $e_{st}$ , and  $e_{gt}$  are serially uncorrelated and uncorrelated with the predetermined and exogenous regressors. Yet these error terms are almost

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<sup>6</sup>We follow Feldstein and Horioka (1980), Dooley, Frankel, and Mathieson (1987), and others in treating the dependency share as an exogenous variable.

certainly correlated with each other, and cannot be used for tracing out the impact of “structural” shocks to real GDP growth or the saving rate as the reduced form errors are linear combinations of the desired structural shocks  $\varepsilon_{gt}$  and  $\varepsilon_{st}$ .<sup>7</sup>

To study the dynamic response of the saving rate to a shock to real GDP growth, say due to an improvement in productivity, it is necessary to impose some restrictions on the relationship between the reduced form errors  $e_t = (e_{st}, e_{gt})'$  and the unknown structural shocks,  $\varepsilon_t = (\varepsilon_{st}, \varepsilon_{gt})'$ . While a large number of methods has been suggested for identifying structural shocks in VAR analysis, for our analysis of the saving rate and real growth, the recursive system introduced by Sims (1980) is suggested by theory.<sup>8</sup> Standard growth models imply that productivity shocks will have an immediate impact on the growth of real output, whereas shocks to the saving rate will only impact output with a lag via the accumulation of capital. Imposing the restriction that shocks to the saving rate have no contemporaneous effect on real GDP growth,  $b_{21} = 0$ , we can rewrite the structural VARX in recursive form.<sup>9</sup>

$$s_t = b_{10} - b_{12}g_t + \gamma_{11}s_{t-1} + \gamma_{12}g_{t-1} + \omega_{10}d_t + \omega_{11}d_{t-1} + \varepsilon_{st} \quad (5)$$

$$g_t = b_{20} + \gamma_{21}g_{t-1} + \gamma_{22}s_{t-1} + \omega_{20}d_t + \omega_{21}d_{t-1} + \varepsilon_{gt}. \quad (6)$$

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<sup>7</sup>Writing the structural and reduced form VARs in matrix form we have  $Bx_t = \Gamma_0 + \Gamma_1x_{t-1} + \omega_0d_t + \omega_1d_{t-1} + \varepsilon_t$  and  $x_t = A_0 + A_1x_{t-1} + W_0d_t + W_1d_{t-1} + e_t$ , where  $x_t = (s_t, g_t)'$ ,  $e_t = (e_s, e_g)'$ ,  $\varepsilon_t = (\varepsilon_s, \varepsilon_g)'$ , and

$A_i = B^{-1}\Gamma_i$ ,  $W_i = B^{-1}\omega_i$ , for  $i = 0, 1$  with  $B = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}$ . The relationship between the structural shocks and

the reduced form errors is  $e_t = B^{-1}\varepsilon_t$ .

<sup>8</sup>See Watson (1994), or Enders (2004) for a discussion of common methods of identification.

<sup>9</sup>This restriction is exactly the same as would be obtained by using a Choleski decomposition to form a triangular version of the variance covariance matrix for the reduced form VAR. That is, the restriction  $b_{21} = 0$  implies that

$e_{st} = \varepsilon_{st} - b_{12}\varepsilon_{gt}$ ,  $e_{gt} = \varepsilon_{gt}$ , and  $E(ee') = \Sigma = \begin{bmatrix} \sigma_s^2 + b_{12}^2\sigma_g^2 & -b_{12}\sigma_g^2 \\ 0 & \sigma_g^2 \end{bmatrix}$ . Note that other restrictions are also possible. For

example, we could follow Blanchard and Quah (1989) and impose the restriction that shocks to the saving rate do not have permanent effects on real GDP growth as is also implied by the neoclassical growth model.

Below we estimate equations (5) and (6) and evaluate the dynamic relationship between saving and growth using impulse response analysis and simulation of our model. But first we evaluate the stochastic properties of each time series in our model. We conduct GLS detrended Augmented Dickey Fuller (DF-GLS) tests for unit roots in the saving rate, GDP growth rate and dependency share (see Elliott, Rothenberg, and Stock 1996). Based on Figure 5, it appears that both the saving rate and the dependency share may be  $I(1)$  processes, while real GDP growth is likely  $I(0)$ , and our results confirm these expectations. We reject the null hypothesis of a unit root in real GDP growth at the 5 percent marginal significance level based on the DF-GLS test, but are unable to reject the same null for either the saving rate or the dependency ratio.<sup>10</sup>

Because of the possibility that some of our series are  $I(1)$  processes, we follow the prescriptions of Sims, Stock, and Watson (1990) for testing hypotheses in VARs that contain a mixture of  $I(1)$  and  $I(0)$  processes.<sup>11</sup> For example, while Wald tests for the null hypothesis that an  $I(0)$  series such as real GDP growth Granger-causes an  $I(1)$  series such as the saving rate will have a limiting  $\chi^2$  distribution, the converse is not true. And, tests of whether an  $I(1)$  series such as the dependency ratio Granger-causes another  $I(1)$  series will not have a limiting  $\chi^2$  distribution unless the two series are cointegrated.

To select the lag length for our recursive VARX, we begin estimating a  $VARX(p)$  with a maximum lag length of  $p=4$ .

$$y_t = c + \sum_{i=1}^p \phi_i y_{t-i} + \sum_{j=0}^p \omega_j d_{t-j} + e_t. \quad (7)$$

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<sup>10</sup>Results are available from the authors on request.

<sup>11</sup>See Watson (1994) or Enders (2004) for accessible summaries of the problems with, and prescriptions for, dealing with mixed  $I(1)$  and  $I(0)$  VAR analysis.

We test the null hypothesis  $H_0 : \phi_p = \omega_p = 0$ , for  $p=4, \dots, 1$ . We are unable to reject the null hypothesis that all coefficients on lags 4 or 3 are jointly equal to zero, but we reject the null hypothesis that all coefficients on lag 2 are zero at the five percent marginal significance level.

We next estimate the recursive VARX in equations (5) and (6) with the lag length set to two. Given our sample of only 29 years of data, we choose to further restrict our model.<sup>12</sup> However, given the possibility that at least two of the three series under study are  $I(1)$  processes, we do not rely on Granger causality tests to inform our restrictions. Instead, we use results from t-tests on single lags of individual series. As in the case of the lag length selection, so long as it is possible to rewrite our recursive VARX so that the hypothesis we are testing concerns a coefficient on a zero mean stationary regressor, our t-tests will be normally distributed. For example in our equation for the saving rate, we exclude both lags of the dependency ratio based on t-statistics near zero, and we exclude the second lag of the saving rate for the same reason. In the equation for real GDP growth, we exclude the dependency ratio at all lags (including the contemporaneous value) based on t-statistics of 0.5 or smaller and the expectation that the dependency ratio should have no affect on GDP growth other than through its impact on the saving rate. We also exclude the second lag of the dependent variable.

Because we have moved away from a system where each equation has exactly the same regressors, we estimate our two-variable system as a Seemingly Unrelated Regression, and calculate impulse responses and confidence intervals using Monte Carlo integration with importance sampling.<sup>13</sup>

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<sup>12</sup>Krolzig (2003) suggests general-to-specific reduction strategy to reduce the large number of parameters and resulting estimation uncertainty in SVAR impulse responses. He shows that the GETS reduction strategy produces impulse responses that are more precisely estimated than from unrestricted SVARs. We do not follow his recommendation to apply the specific PcGETS reduction strategy because his analysis assumes no unit root processes in his VAR

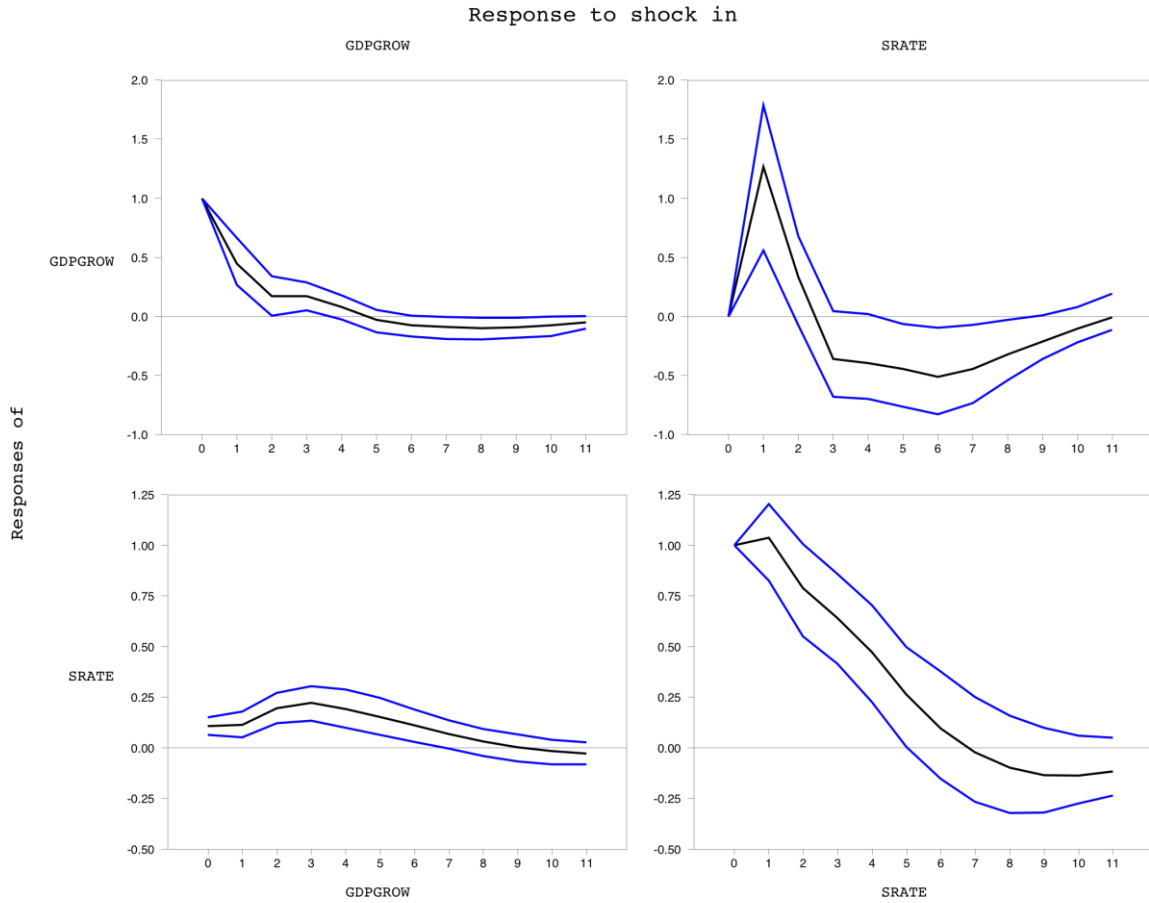
<sup>13</sup>All calculations are done using RATS v7.1. We use the montesur.prg written by Thomas Doan for calculating

Impulse response functions are shown in Figure 6. The first column of graphs presents the results for a unit shock to real GDP growth and the second column of graphs presents the results for a unit shock to the saving rate. The recursive nature of the model is clear in the top right quadrant where real GDP growth shows no response to a one percentage point shock to the saving rate at time  $t + 0$ , but a positive and significant response in period  $t + 1$  and  $t + 2$ . Three periods after the shock to the saving rate, the response of real GDP growth is insignificantly different from zero and remains very nearly zero from then on. In the lower right quadrant, we see evidence of the persistence of the saving rate that we also found in our unit root tests reported above. A one-unit shock to the saving rate in period  $t + 0$  actually raises the saving rate further in period  $t + 1$  due in part to the impact of higher GDP growth in that period. The own shock to the saving rate takes more than five years to die off completely. The own shock to real GDP growth dies off relatively quickly and is consistent with our finding that real GDP growth is stationary. We interpret the limited persistence of real growth to its own shock as the result of feedback from the highly persistent saving rate. That is, an initial shock to real GDP boosts the saving rate and the lingering impact of that in turn boosts GDP growth. The lower left quadrant of Figure 6 shows a one percentage point shock to real GDP growth has a statistically significant positive impact on the saving rate for six years after the initial shock.

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impulse responses and fractiles of the distribution of simulated responses. Following Sims and Zha (1999) we use 16 percent and 84 percent fractiles corresponding to one standard deviation for symmetrical error bands based on estimates of the variance. All data and programs are available from the authors on request.

**Figure 6: Impulse Response Functions**



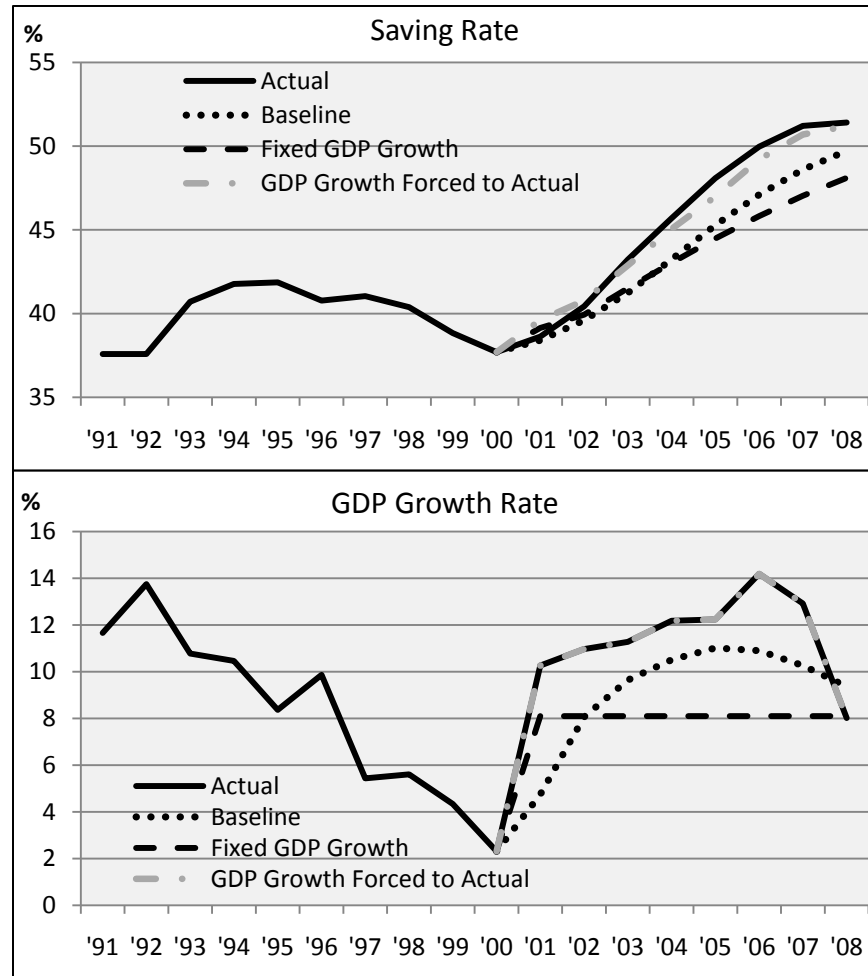
While the shock to real GDP growth produces a statistically significant response in the saving rate, at first glance the saving rate response appears small. Cumulating the responses indicates that a 1 percentage point jump in real GDP growth leads to a sixty-four basis point increase in the saving rate after three years, and a maximum impact of 1.2 percentage points after seven years. These results are similar in magnitude to those obtained by Loayza et al. and Horioka and Wan.

#### **4. Simulations**

To further disentangle the role of real GDP growth and the dependency share in the movement of China's saving rate, we have conducted a number of simulations of our VARX. We are interested in explaining the surge in China's saving rate from a trough of 37.7 percent in 2000 to 51.4 percent in 2008. We first use our model to prepare dynamic forecasts over the eight-year period from 2001 to 2008. These forecasts are based on the model estimated over the full sample, so we are primarily illustrating the goodness of fit of the model. But these are dynamic forecasts where predicted values for the saving rate and real GDP growth at time  $t=2000$  are used to predict subsequent rates in  $t+1, \dots, T=2008$ . We treat the dependency share as an exogenous variable throughout.

The baseline forecast for the saving rate shown in the upper panel of Figure 7 indicates that our model explains most of the increase in the saving rate. Our dynamic forecast of the saving rate climbs to 49.7 percent by 2008, only 1.7 percentage points below its actual value. The difference between our dynamic in-sample forecast and the actual saving rate is due to two factors. First, model misspecification and the stochastic shocks to both series cause forecasted values to differ from actual values. Second, as illustrated in the lower panel of Figure 7, our baseline GDP growth rate forecast is below the actual growth path throughout the entire forecast period but for the final year. Over this period, China's actual GDP growth accelerated from a recessionary low of 2.3 percent in 2000 to more than 14 percent in 2006 before settling down to 8.0 percent in 2008. The actual compound average GDP growth rate was 11.1 percent vs our baseline forecast of 9.3 percent.

**Figure 7: Simulations for Alternative GDP Growth Scenarios**



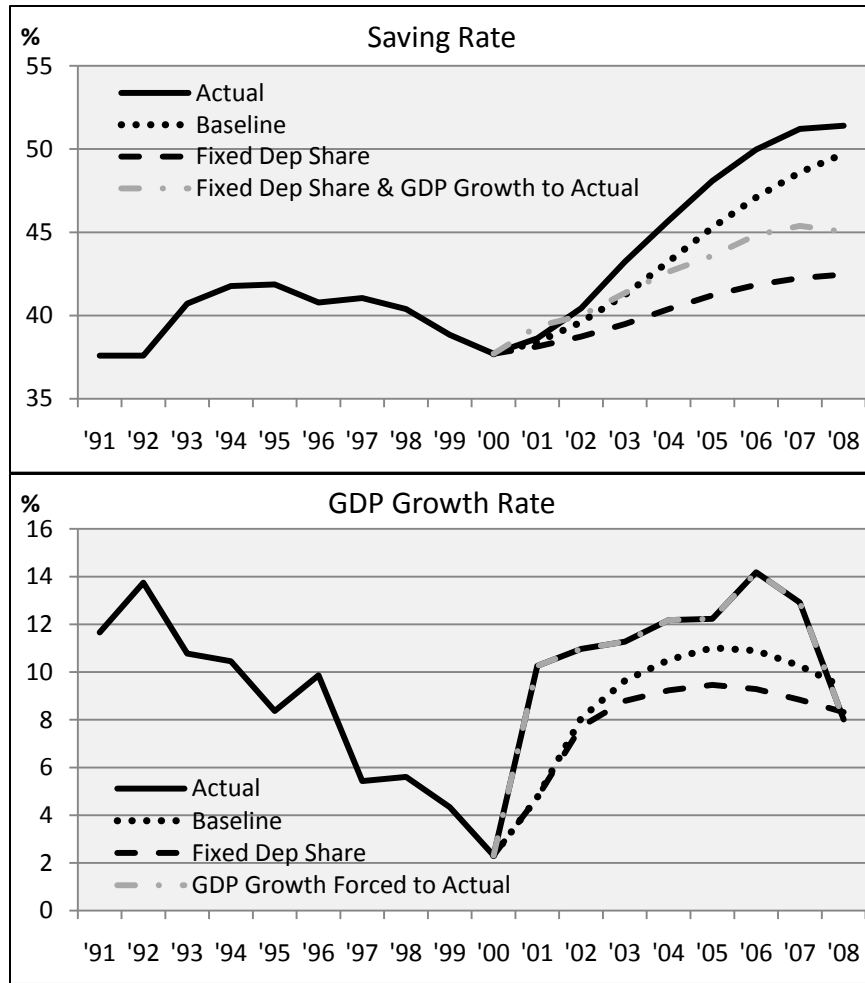
To explore how much of the shortfall in the saving forecast is due to our model’s failure to capture the growth boom over this period, we generate a second forecast for the saving rate while forcing simulated GDP growth to match the reality. This forecast is labeled “GDP Growth Forced to Actual” in Figure 7. Clearly, most of the shortfall in our baseline saving rate forecast is due to our model under-predicting real GDP growth during the boom years. Another way to see the effect of China’s tremendous growth on saving is to simulate our model under the assumption that real GDP growth over the 2001 to 2008 period remained constant at its average value over the previous two decades of 8.1 percent. Forcing GDP growth to be a full 3



percentage points lower than its actual rate from 2001 through 2008 leads to a peak saving rate in 2007 that is 1.6 percentage points below the baseline forecast and 3.3 percentage points below the actual saving rate.

While the surge in real GDP growth clearly played a role in explaining China's saving rate increase of 13.7 percentage points from 2000 to 2008, it is not the whole story. To explore the role of demographics, we prepare another dynamic forecast where we hold the dependency share fixed at its value in 2000 with the results shown in Figure 8. Over the period 2000 to 2008, the actual dependency share in China fell from 32.5 to 28.5. Fixing the dependency share at its 2000 level and simulating our VARX produces a saving rate forecast for 2008 that is 8.9 percentage points lower than the actual rate. Demographics thus figure enormously in the saving rate run-up of the 2000s.

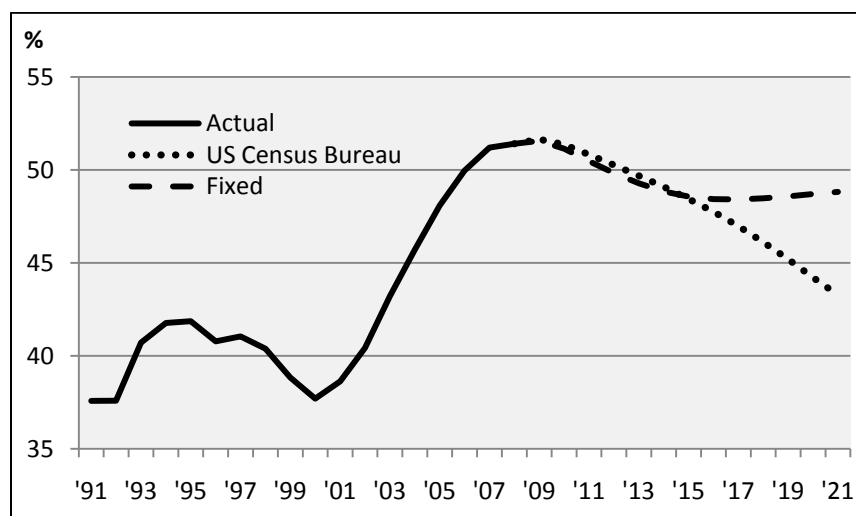
**Figure 8: Simulations for Alternative Dependent Share Scenarios**



To summarize, the dynamic forecast simulation from our VARX model explains all but 1.6 percentage points of the 13.7 percentage point increase in the saving rate that occurred over the 2000-2008 period. When we impose actual GDP growth in place of our baseline growth rate, our model explains all but 0.2 percentage points of the saving rate increase. By contrast, when we hold GDP growth to its historic mean of 8.1 percent, 3.3 percentage points of the actual saving rate increase are left unexplained. And when we hold the dependent share constant at its 2000 level rather than letting it follow its actual declining path, at the same time forcing GDP growth to actual, 6.4 percentage points of the actual saving rate increase are left unexplained.

That the rise in the saving rate in the 2000s may be explained by a falling dependency share and rapid GDP growth suggests that a reversal in these forces may bring a decline in the saving rate in the future. We assess the tendencies for this by undertaking an out-of-sample forecast based on projections for China's dependency share. The projections, from the US Census Bureau, show the dependency share rising from 28.5 percent in 2008 to 31.9 percent in 2021. For comparative purposes, we also run a simulation with the dependency share fixed at its 2008 level. The GDP growth rate is determined endogenously in the simulations. As shown in Figure 9, both simulations predict an immediate turnaround in the saving rate as the dependent share levels out and the growth rate slows. Under the Census Bureau projection, the saving rate continues downward as the dependent share rises reaching about 43 percent by 2021. By contrast, with the dependency share held constant the saving rate levels out around 48 percent.

**Figure 9: Saving Rate Forecast for Alternative Dependent Share Projections, 2009-2021**



Our simple VARX predicts that GDP growth will vacillate down to a modest four to five percent rate in the coming decade. That together with the expected turnaround in the dependent share yields a steady decline in the saving rate. Our forecast is for a decline of about three-

quarters of a percentage point per year, which is well short of the torrid two percentage point per year pace at which it went up. Were GDP growth to slow more drastically, the decline in the saving rate would be quicker, but that is hardly a recipe for rebalancing. Policy interventions could also steepen the pace of decline.

## **5. Conclusion**

The increase in China's national saving rate during the 2000s can be largely explained by the combination of a declining dependent share in the population and an extraordinarily high GDP growth rate. We estimate a structural VARX model for 1978 to 2008 treating the saving rate and GDP growth as endogenous and the dependency share as exogenous. We demonstrate the model's ability to explain the behavior of China's saving rate by dynamic simulation over the 2000 to 2008 sample. With GDP growth determined endogenously, the model explains all but 1.7 percentage points of the 13.7 percentage point run-up in the saving rate. Actual GDP growth was substantially higher than the model predicts. When we simulate the model while forcing GDP growth to follow its actual path, all but 0.2 percentage points of the saving rate increase is explained.

As of 2010, both the dependent share and the GDP growth rate are due for a course change. After decades of decline, the dependent share is bottoming out and poised to move up as fast as it went down. The GDP growth rate cannot be predicted with as much certainty, but clearly the 12 percent average rate (by our estimation) sustained during the 2001-07 period must give way to a more measured pace which, judging by the historical record for the preceding two decades, may be more on the order of 8 percent, and even that would be an impressive feat at this stage in China's development. What these prognostications mean for the saving rate is that it can

be expected to come back down. Our dynamic simulation shows a pace of decline of about three-quarters of a percentage point per year over the span of a decade to reach 43.3 percent by 2021. That pace would be hastened by slower GDP growth or effective policy interventions.

This 43.3 percent marker puts the saving rate back where it was in 2003 and close to where domestic investment rates have been throughout the mid to late 2000s. With saving and domestic investment aligned at this level, the reliance on net exports to sustain aggregate demand would be eliminated.

We have argued that popular explanations for China's saving rate increase do not fit the historical facts. The saving rate did not take up its rise until the 2000s and indeed was falling through the late 1990s. Neither a precautionary story of saving nor an income distribution story jibes with this. Reform dislocations were at a peak in the late 1990s as the saving rate was declining. The 2000s then ushered in strong growth and a gradual rebuilding of the social safety net yet the saving rate soared. Likewise, a pattern of income redistribution from households to enterprises applies mainly to the late 1990s with a more mixed picture emerging by the mid 2000s as government claimed a greater share of income and the enterprise share fluctuated. Overriding any distributional dynamic was a clearcut decline in the household saving rate in the late 1990s and a powerful increase in the 2000s. This carried through to the household saving share in national disposable income, so it is household behavior that must be explained to illuminate what happened to the aggregate saving rate.

That the precautionary motive and the institutional distribution of income are not manifestly associated with the run-up in the national saving rate does not mean these factors are irrelevant in the quest to achieve rebalancing. But this is almost beside the point. Most of the policy prescriptions involved are worth pursuing apart from any impact they may have on saving.

Rebuilding the social safety net, strengthening public support for health care and education, developing the financial system, and eliminating price distortions are all justifiable on equity and/or efficiency grounds. Any impact such measures have on expediting rebalancing is a bonus.

The measure that has gotten most attention, however, does not stand on such unequivocal merit. That measure is the revaluing of the exchange rate. While on the surface appreciation of the renminbi would seem to encourage imports and discourage exports, any story of achieving external balance via this route must have an associated story for bringing about domestic balance between saving and investment. The premise that an undervalued currency has redistributed income from consuming households to saving enterprises is undercut as an explanation for the rising saving rate because such a shift in income distribution did not coincide with the saving rate rise. Indeed, a marked shift in income from households to enterprises took place in the late 1990s even as the saving rate was falling. Nor does the argument hold water that renminbi appreciation would increase household real income and thereby household consumption. The rapid increase in household income that actually occurred in the 2000s simply was not met with an equally rapid increase in household consumption.

We subscribe to the view that household consumption is in significant part a function of habit. That makes saving more of a residual, either absorbing or being diminished by income changes. Akerlof and Shiller (2010, 122) see saving as imbued with animal spirits, describing it as “haphazard” and prone to “the default option”. Looked at in this way, the rate of increase in Chinese consumption in the 2000s was actually incredibly fast. In nominal terms, consumption grew at an annual compound rate of 11.7 percent between 2000 and 2008 even as GDP grew at 15.2 percent. (Our derived GDP deflator increased at 3.7 percent.) In an extremely rapidly expanding pie, consumption was a shrinking share despite the slice itself enlarging greatly. The

consumption standards of the Chinese people improved by leaps and bounds. This involves lifestyle changes. Exploiting the possibilities presented by fast rising incomes takes time. In the interim, saving absorbs the difference.

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